

Attorney Docket No. 07977/019002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of )  
Shunpei YAMAZAKI et al. )  
Serial No. 09/126,826 ) Group Art Unit: 2871  
Filed: July 31, 1998 ) Examiner: Nguyen, D  
For: METHOD FOR PRODUCING )  
DISPLAY DEVICE )

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VERIFICATION OF TRANSLATION

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Sir:

I, Ikuko Noda, 3-G, 1551, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached translation of the Japanese Patent Application No.7-88759 filed on March 22, 1995; and

that to the best of my knowledge and belief the following is a true and correct translation of the Japanese Patent Application No.7-88759 filed on March 22, 1995.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 29th day of April, 2000

Name: Ikuko Noda

|                                       |  |
|---------------------------------------|--|
| [Name of Document]                    | Patent Application   |
| [Reference Number]                    | P002966-01   |
| [Filing Date]                         | March 22, 1995   |
| [Attention]                           | Commissioner, Patent Office  |
| [International Patent Classification] | G02F 1/133   |
| [Title of Invention]                  | LIQUID CRYSTAL DISPLAY DEVICE  |
| [Number of Claims]                    | 3  |
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| [Indication of Handlings]             |  |
| [Payment Method]                      | Prepayment   |
| [Number of Prepayment Note]           | 002543   |

|                  |       |
|------------------|-------|
| [Payment Amount] | 21000 |
|------------------|-------|

|                      |  |
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| [List of Attachment] |  |
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|--------------|---------------|---|
| [Attachment] | Specification | 1 |
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| [Attachment] | Drawing | 1 |
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| [Attachment] | Abstract | 1 |
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[NAME OF DOCUMENT]      Specification

[TITLE OF THE INVENTION]      LIQUID CRYSTAL DISPLAY DEVICE

[WHAT IS CLAIMED IS:]

1. A passive matrix type liquid crystal display device comprising:

    a first peripheral driver circuit formed over a first substrate, comprising a first electrical wiring comprising a transparent conductive film and a thin film transistor connected to said first electrical wiring;

    a second peripheral driver circuit formed over a second substrate, comprising a second electrical wiring comprising a transparent conductive film and a thin film transistor connected to said second electrical wiring, said first and second peripheral driver circuits are opposed to each other;

    a spacer provided between the first substrate and the second substrate;

    a seal material provided in an opposing region of the first and second substrates, and outside of a region on which the first and second electrical wirings and the first and second peripheral driver circuits are formed; and

    a liquid crystal material filled in a region inside the first and second substrates, and the seal material;

    wherein a protective film is formed on the first and second peripheral driver circuit at a thickness having substantially the same as the spacers,

    wherein the first and second peripheral driving circuits are obtained by peeling from another substrate and forming over the first and second substrates.

2. An active matrix type liquid crystal display device at least comprising:

    a peripheral driving circuit formed over a first substrate, comprising an active matrix circuit and a thin film transistor connected to the active matrix circuit;

    a second substrate formed in opposite to the first substrate, comprising a

transparent conductive film and having an opposing size of at least the active matrix circuit and the peripheral driver circuit;

a spacer provided between the first substrate and the second substrate;

a seal material provided outside of said active matrix circuit and the peripheral driver circuit; and

a liquid crystal material filled in a region inside the first and second substrates, and the seal material;

wherein a protective film is formed on the peripheral driver circuit at a thickness of having substantially the same as the seal material,

wherein the peripheral driving circuit is obtained by peeling from another substrate and forming over the first substrate.

3. The method of claim 1 or claim 2 wherein at least the first substrate comprises a plastic.

#### [DETAILED DESCRIPTION OF THE INVENTION]

[0001]

#### [FIELD OF INDUSTRIAL USE]

The present invention relates to a structure in order to improve reliability and durability of a liquid crystal display device having a passive matrix system or an active matrix system.

[0002]

#### [DESCRIPTION OF THE RELATED ART]

Passive matrix type displays and active matrix type devices have been known as a matrix type liquid crystal display device.

In the passive matrix type liquid crystal display device, a first plurality of strip

type electrode wirings made of a transparent conductive film are provided on a first substrate and extended to a first direction. A second plurality of electrode wirings made of a transparent conductive film are provided on a second substrate and extended to a direction substantially perpendicular to the first direction. The first electrode wirings are provided to be opposite to the second electrode wiring through spacers scattered between the first and second substrates. A liquid crystal material is filled between the first and second electrode wirings and sealed by mainly a seal material (member) which is provided in periphery of a region that the first substrate is opposite to the second substrate.

A peripheral driver circuit, which is connected to the first and second electrode wirings and controls pixels formed by these electrode wirings and the liquid crystal material, is provided outside the region that the first substrate is opposite to the second substrate.

[0003]

In the passive matrix type liquid crystal display device, since a complex process is not performed except that a transparent conductive film is formed on a substrate and then etched to form a strip type electrode wiring and the substrate is treated at a low temperature, a plastic substrate as well as a glass substrate can be used as the first and the second substrates.

[0004]

In an active matrix driver type liquid crystal display device, an active matrix circuit which is provided on a first substrate is disposed to be opposite to a second substrate (an opposite substrate) that an opposite electrode of a transparent electrode is provided on the whole surface, through spacers scattered on the first substrate. A liquid crystal material is filled between the first and second electrode wirings and sealed by

mainly a seal material which is provided in periphery of a region that the first substrate is opposite to the second substrate. In the active matrix circuit, pixel electrodes connected to TFTs are disposed in a plurality of matrix forms.

Outside the region that the first substrate is opposite to the second substrate, a source driver circuit and a gate driver circuit are provided as a peripheral driver circuit for driving the active matrix circuit.

[0005]

#### [PROBLEM TO BE SOLVED BY THE INVENTION]

Thus, in a liquid crystal display device having a conventional structure, the peripheral driver circuit is formed with a semiconductor integrated circuit mounted by using tape automated bonding (TAB) method or chip on glass (COG) method. However, since the number of electrode wirings for constructing a display screen reaches about several hundred and a driver circuit is constructed by an IC package and a semiconductor chip, it is necessary to lead wirings in order to connect these terminals to electrical wirings on a substrate, thereby there arises a problem that an area of peripheral portion cannot be neglected because this area is large in comparison with a display screen.

[0006]

To solve the above problem, there is a method forming directly a semiconductor integrated circuit using TFTs on a substrate except a region in that the first substrate is opposite to the second substrate and pixels are formed. Also, there is a method for obtaining the semiconductor integrated circuit by forming directly a driver circuit on a substrate on which a silicon thin film is deposited using an integrated circuit producing technique. In another method, a semiconductor integrated circuit using TFTs is formed on other supporting substrate by using the same technique, and then peeled to adhere it

on the first and second substrates, or adhered to the substrate before removing an original supporting substrate.

In a liquid crystal display device having such a structure, it is necessary to provide a protective film made of an organic resin and a silicon nitride system substance in order to prevent the semiconductor integrated circuit from contaminating due to an impurity such as moisture, dust, sodium. However, when such a structure is used, stress due to the protective film acts to the TFTs constructing the semiconductor integrated circuit. Thus, a density of a recombination center of silicon constructing the TFT is increased and various characteristics such as threshold voltage of the TFT are changed. Also, a characteristic of the TFT constructing the semiconductor integrated circuit is changed by influence due to a pressure applied from an external after the liquid crystal display device is completed.

[0007]

To solve the above problem, another example of a conventional liquid crystal display device is shown in Fig. 3. An active matrix type liquid crystal display device is shown in Fig. 3.

In Fig. 3, an active matrix circuit 302, a source driver circuit 303 and a gate driver circuit 304 that are provided on a first substrate 301, and a second substrate on which an opposite electrode (counter substrate) (not shown) provided entirely, are provided through spacers (not shown) that are scattered on the first substrate 301. Between both electrodes a liquid crystal material 306 is filled and sealed by a seal material 302.

In Fig. 3, not only the active matrix circuit but also the source driver circuit and the gate driver circuit which are a peripheral driver circuit are opposite to the counter substrate to be in contact with the liquid crystal material. That is, by the liquid crystal material, TFTs constructing the peripheral driver circuit are protected. This structure is

disclosed in Japanese Patent Application Laid-Open No. 5-66413, for example.

[0008]

In the liquid crystal display device, spacers which have a spherical shape, a stick shape, an angular shape or the like between the substrates and are made of a hard material such as silica are scattered uniformly, to maintain an interval between two substrates. Each spacer has a diameter corresponding to the same length as an interval between the substrates. The diameter is about 3  $\mu\text{m}$  to 8  $\mu\text{m}$  in a display device using a nematic liquid crystal, and about 1  $\mu\text{m}$  to 4  $\mu\text{m}$  in a display device using a smectic liquid crystal. The number of the spacers is about 50 to 1000 per one pixel in a case wherein a size of one pixel is several 10  $\mu\text{m}$  square to several 100  $\mu\text{m}$  square.

[0009]

In the peripheral driver circuit, a large number of TFTs are provided extremely adjacent to one another. Thus, in the liquid crystal display device of Fig. 3, since the peripheral driver circuit is provided within a liquid crystal region, if external stress is applied to the substrates, the peripheral driver circuit may be broken by the spacers provided between the substrates. Thus, the peripheral driver circuit do not operate regularly, a point defect and a line defect occur in a display and further a display may be impossible, so that reliability and durability of the liquid crystal display device are reduced. Further, such a phenomenon occurs remarkably in the liquid crystal display device using a plastic substrate which is modifiable by external stress.

[0010]

#### [PROBLEMS TO BE SOLVED BY THE INVENTION]

Also, to obtain a small and light-weight liquid crystal display device by providing a peripheral driver circuit for controlling display pixels and electrode wirings in a region in which a liquid crystal is injected, the object of the present invention is to prevent the

peripheral driver circuit and TFTs constructing the peripheral driver circuit from breaking due to stress application to the substrates and to improve reliability and durability of the device.

[0011]

[MEANS TO SOLVE THE PROBLEM]

To solve the problem, according to one structure of the present invention, there is provided a liquid crystal display device comprises at least a first substrate in which a passive matrix circuit and a peripheral driver circuit are provided, a second substrate provided to be opposite to the first substrate in which a passive matrix circuit and a peripheral driver circuit are formed, said second substrate having at least a size corresponding to the passive matrix circuit and the peripheral driver circuit, spacers provided between the first and second substrates to maintain a desired substrate interval, a seal material formed outside at least the passive matrix circuits and the peripheral driver circuits in the first and second substrates, and a liquid crystal material filled inside a region enclosed by the seal material, wherein a protective film formed on the peripheral driver circuit has substantially a thickness equivalent to an interval between the substrates which is formed by the spacers.

[0012]

According to another structure of the present invention, there is provided a liquid crystal display device comprises a first substrate in which an active matrix circuit and a peripheral driver circuit are provided, a second substrate which is provided to be opposite to the first substrate and has at least a size corresponding to the active matrix circuit and the peripheral driver circuit, spacers provided between the first and second substrates to maintain a desired substrate interval, a seal material formed outside at least the active matrix circuits and the peripheral driver circuits in the first and second

substrates, and a liquid crystal material filled inside a region enclosed by the seal material, wherein a protective film formed on the peripheral driver circuit has substantially a thickness equivalent to an interval between the substrates which is formed by the spacers.

[0013]

Fig. 1 shows an example of a liquid crystal display device according to the present invention. In Fig. 1, a first substrate 101 made of glass, plastic or the like and a second substrate 102 (not shown) which is a counter substrate are provided to be opposite to one another with a counter electrode provided inside.

On the first substrate 101, a large number of electrode wirings made of a transparent conductive film and a peripheral driver circuit 103 connected to the electrode wirings are provided. Also, on the second substrate 102, a large number of electrode wirings made of a transparent conductive film and a peripheral driver circuit 104 connected to the electrode wirings are provided.

In a region outside a large number of electrode wirings made of the transparent conductive film and the peripheral driver circuits in the first and second substrates, a seal material 107 is provided, and a liquid crystal material 106 which is injected from a liquid crystal inlet (not shown) is filled. A plurality of spacers are provided in a region that the liquid crystal material is injected.

On the peripheral driver circuits 103 and 104, protective films 110 and 111 are further provided. A thickness of the protective films is substantially the same as an interval between the substrates which is formed by the spacers.

[0014]

Fig. 4 shows a cross section along a line A-A' in Fig. 1. The protective film 110 is provided on the peripheral driver circuit 103 as shown in Figs. 1 and 4. Also, between

the first and second substrates, spacers 401 having a spherical shape is scattered uniformly.

In the present invention, since the protective film 110 provided on the peripheral driver circuit 103 in the substrate 101 has a thickness substantially equivalent to an interval between the substrates which is formed by the spacers, a concentration of local stress due to external stress 402 can be suppressed and breaking of the peripheral driver circuit can be prevented.

[0015]

A schematic order of processes for producing such a display device is shown in Fig. 2. Fig. 2 shows an order of processes for producing a passive matrix type display device. First, a plurality of peripheral driver circuits 22 are formed on a suitable substrate 21.(Fig. 2(A))

[0016]

Stick substrates 23 and 24 are obtained by cutting the substrate.

Electric characteristic of the obtained stick substrates are tested before performing next process, to select good products and defectives. (Fig. 2(B))

Then, surfaces of the stick substrates 23 and 24 on which the peripheral driver circuit is formed are adhered on surfaces 26 and 28 of another substrates 25 and 27 in which patterns of wirings made of a transparent conductive film are formed, thereby connecting electrically. (Figs. 2(C) and 2(D))

[0017]

Thereafter, the stick substrates 23 and 24 are peeled so as to remain only the peripheral driver circuits 29 and 30 on the surfaces 26 and 28 of the substrates. (Figs. 2(E) and 2(F))

Finally, the substrates obtained in this way are opposed to one another, so that a

passive matrix type display device is obtained. A surface 26 is a reverse surface of the surface 26, i.e., a surface on which a wiring pattern is not formed. (Fig. 2(G))

[0018]

In the above case, the peripheral driver circuits are divided from the same substrate 21. However, these circuits may be divided from another substrate.

Although a passive matrix type display device is shown in Fig. 2, the same process may be performed for an active matrix type display device. Further, since a driver circuit is formed on another substrate and then adhered, a material such as a plastic film can be used as a substrate.

[0019]

[OPERATION]

According to the present invention, in a liquid crystal display device wherein a matrix circuit and a peripheral driver circuit are provided in a liquid crystal region, and a protective film having a thickness substantially equivalent to a size of the spacers scattered in the liquid crystal region is provided on the peripheral driver circuit, so that breaking of TFTs constructing the peripheral circuit due to stress application to the substrates can be prevented and an interval between the substrates can be maintained to be constant. Thus, reliability and durability of the liquid crystal display device can be improved.

The following is an embodiment of the present invention.

[0020]

[EMBODIMENT]

[EMBODIMENT 1]

The embodiment shows a schematic producing process for one substrate in a passive matrix type liquid crystal display device. The present embodiment will be

explained using Figs. 5 and 6. Fig. 5 shows a schematic process for forming a peripheral driver circuit on a stick substrate, and Fig. 6 shows a schematic process for forming the peripheral driver circuit provided on a stick substrate on a substrate in a liquid crystal display device.

[0021]

A silicon film 32 having a thickness of 3000 Å is deposited as a peeling layer on a glass substrate 31. Since this silicon film 32 is etched when a circuit formed thereon is peeled from the substrate, there is no problem almost with respect to a film quality, so that the silicon film may be deposited by a method that mass-production is possible. The silicon film may be amorphous or crystalline.

[0022]

As the glass substrate, a glass containing no alkali or alkali at a low concentration or a quartz glass such as Corning 7059, Corning 1737, NH technoglass NA 45, NH technoglass NA 35 or Japan electric glass OA2 may be used. When a quartz glass is used, there is a problem in its cost. However, since, in the present invention, an area used in one liquid crystal display device is extremely small, a cost per unit is sufficiently low.

[0023]

A silicon oxide film 33 having a thickness of 5000Å is deposited on the silicon film 32. Since the silicon oxide film is used as a base film, it is necessary to pay sufficient attention to its formation. By a known method, crystalline island silicon regions (silicon islands) 34 and 35 are formed. A thickness of this silicon film influences characteristics of a necessary semiconductor circuit. In general, it is preferable to be a thin film. In the embodiment, the thickness is 400 to 600Å.

[0024]

To obtain a crystalline silicon, a method for irradiating an intense light such as a laser into amorphous silicon (a laser annealing method) or a method for making solid phase growth by thermal annealing (a solid phase growth method) is used. In using the solid phase growth method, as disclosed in Japanese Patent Application Laid-Open No. 6-244104, when a catalytic element such as nickel is added to silicon, a crystallization temperature can be reduced and an annealing time can be shortened. Also, as disclosed in Japanese Patent Application Laid-Open No. 6-318701, silicon crystallized by the solid phase growth method may be annealed by laser. A method to be used may be determined in accordance with characteristics of a necessary semiconductor integrated circuit, a heat-resistance temperature of a substrate and the like.

[0025]

By plasma chemical vapor deposition (plasma CVD) or thermal CVD, a gate insulating film 36 made of silicon oxide having a thickness of 1200Å is deposited, and then gate electrode-wirings 37 and 38 using crystalline silicon having a thickness of 5000Å are formed. The gate wirings may be a metal such as aluminum, tungsten or titanium, or silicide thereof. When metal gate electrode is formed, as disclosed in Japanese Patent Application Laid-Open No. 5-267667 or 6-338612, an upper surface or a side surface of the gate electrode may be coated with an anodic oxide. A material constructing the gate electrode may be determined in accordance with characteristics of a necessary semiconductor circuit, a heat-resistance temperature of a substrate and the like. (Fig. 5(A))

[0026]

In a self-alignment manner, an N-type and a P-type impurities are introduced into the silicon islands by ion doping or the like, to form N-type regions 39 and P-type regions 40. An interlayer insulator 41 (a silicon oxide film having a thickness of 5000Å)

is deposited by a known method, and then contact holes are formed therein, to form aluminum alloy wirings 42 to 44. (Fig. 5(B))

[0027]

A silicon nitride film 46 having a thickness of 2000 Å is deposited as a passivation film by plasma CVD, and then a contact hole for the wiring 44 of an output terminal is formed therein. By sputtering, an electrode 47 made of an Indium Tin Oxide (ITO) film having a thickness of 1000 Å is formed. The ITO film is a transparent conductive oxide. Then, a bump 48 made of gold having a diameter of about 50 μm and a height of about 30 μm is formed mechanically on the ITO electrode 47. The obtained circuit is divided to a desired size, thereby obtaining stick substrates. (Fig. 5(C))

[0028]

On the other hand, as shown in Fig. 6, an ITO electrode 50 having a thickness of 1000 Å is formed on a substrate 49 used in a liquid crystal display device. In the embodiment, the substrate in the liquid crystal display device is polyether sulfide (PES) having a thickness of 0.3 mm. Stress (pressure) are applied to the substrate 49 and the stick substrate 31 to adhere to these substrates one another. At this time, the electrode 47 is connected electrically to the electrode 50 through the bump 48. (Fig. 6(A))

[0029]

An adhesive 51 which is mixed with a thermally curable organic resin is injected into a gap between the stick substrate 31 and the substrate 49 in the liquid crystal display device. The adhesive may be applied to a surface of one of the substrates in advance before the stick substrate 31 is crimped to the substrate 49 in the liquid crystal display device.

[0030]

By processing at 120°C for 15 minutes in an atmosphere containing nitrogen in an

oven, electric connection and mechanical adhesion between the stick substrate 31 and the substrate 49 are completed. Before complete adhesion, it may be tested whether or not sufficient electrical connection state is obtained, by a method disclosed in Japanese Patent Application Laid-Open No. 7-14880, and then a main adhesion method may be utilized. (Fig. 6(B))

[0031]

The processed substrates are left within air flow of a mixture gas of fluorine trichloride ( $\text{ClF}_3$ ) and nitrogen. A flow rate of fluorine trichloride and nitrogen is set to 500 sccm. A reaction pressure is 1 to 10 Torr. A temperature is a room temperature. It has been known that fluorine halide such as fluorine trichloride has a characteristic for selectively etching silicon. On the other hand, silicon oxide is not almost etched. However, oxides (silicon oxide and ITO) are not almost etched. Also, when a stable oxide film is formed on a surface of aluminum, since reaction is stopped, etching is not performed.

[0032]

In the embodiment, a material which is etchable by fluorine trichloride is the peeling layer (silicon) 32, the silicon islands 34 and 35, the gate electrodes 37 and 38, the aluminum alloy wirings 41 to 44 and the adhesive 51. With respect to the materials other than the peeling layer and the adhesive, since a material such as silicon oxide is formed outside the materials, fluorine trichloride cannot reach the materials. Actually, as shown in Fig. 6(C), only the peeling layer 32 is etched selectively, thereby to form holes 52. (Fig. 6(C))

[0033]

When a time elapses, the peeling layer is etched completely, so that a bottom surface 53 of the base film is exposed. Therefore, the stick substrate 31 can be separated

from a semiconductor circuit. In etching using fluorine trichloride, since etching is stopped at the bottom surface of the base film, the bottom surface 53 is extremely flat. (Fig. 6(D))

[0034]

By such processing, a formation of the peripheral driver circuit on one substrate of the liquid crystal display device is completed. Then, a polyimide film is formed as a protective film on the transferred peripheral driver circuit by adding varnish and then curing it. In the embodiment, Photoneath UR-3800 of Toray Industries Inc. is used. Firstly, addition is performed by a spinner. An addition condition may be determined in accordance with a desired film thickness. The polyimide film having a thickness of about 5  $\mu\text{m}$  is formed at 2000 rpm for 20 seconds. After the addition is performed, drying, exposure and development are performed to remove an unnecessary polyimide. The film is then cured by processing it at 300°C in an atmosphere containing nitrogen. It is important that a thickness of the polyimide film is set to be substantially the same as a diameter of spacers to be used later. Thus, it can be prevented that the spacers are present on the peripheral driver circuit. A thickness of the polyimide film may be set to be substantially the same as that of a seal material. However, in general, the thickness of the seal material is determined by the spacers, the thickness of the polyimide film is generally set to be the diameter of the spacers. In a passive matrix type display device, the other substrate is produced by substantially the same process as described above.

[0035]

Next, a producing process for a passive matrix type liquid crystal display device is explained below. The first and second substrates produced by the above processes are sufficiently washed to remove various chemicals such as an etching solution, a resist solution and a peeling solution which are used for each surface-processing.

An alignment film is adhered to an electrode region which is made of ITO and constructs pixels. An alignment material is obtained by dissolving, in a solvent such as butyl cellosolve or N-methyl pyrrolidone, a polyimide having about 10 weight % of the solvent.

The alignment films adhered to the first and second substrates are heated and cured (baked).

Then, rubbing treatment is performed so that a surface of a glass substrate to which the alignment film is adhered is rubbed in a desired direction by using a buff cloth (a fiber such as rayon and nylon) having of a wool length of 2 to 3 mm at a surface and thus fine grooves are formed.

[0036]

Spherical spacers of a polymer system, a glass system, a silica system or the like are scattered (dispersed) on one of the first and second substrates.

A spacer scattering method includes a wet method for scattering, on a substrate, spacers into which a solvent such as pure water or alcohol is mixed and a dry method for scattering, on a substrate, spacers without using a solvent. In the embodiment, the dry method is used.

[0037]

A resin used as a seal material provided in an outer side of a substrate is applied.

The seal material to be used is obtained by dissolving an epoxy resin and a phenol curing agent in a solvent of ethyl cellosolve. An acrylate system resin may be used. Also, a thermal-curable type or a ultraviolet-curable type may be used.

By a screen printing method, a seal material is applied and formed on the first substrate or the second substrate.

[0038]

After forming the seal material, two glass substrates are adhered to one another.

As a method for adhering and curing, a heating curing method for curing a seal material for about 3 hours by high temperature press at about 160 °C is used.

A liquid crystal material is injected from a liquid crystal inlet of the passive matrix display device produced by adhering the first and second substrates, and then the liquid crystal inlet is sealed by using an epoxy system resin.

Thus, the passive matrix type liquid crystal display device is completed.

[0039]

[EMBODIMENT 2]

The embodiment shows a schematic producing process of a passive matrix type liquid crystal display device, using Figs. 7 and 8. Figs. 7 and 8 show a schematic process for forming a peripheral driver circuit on a stick substrate, and a schematic process for forming the driver circuit on a substrate in a liquid crystal display device.

[0040]

A silicon film 151 having a thickness of 3000 Å is deposited as a peeling layer on a glass substrate 150. Since this silicon film 151 is etched when a circuit formed thereon is peeled from the substrate, there is no problem almost with respect to a film quality, so that the silicon film may be deposited by a method that mass-production is possible. Also, the silicon film may be amorphous or crystalline and include another element.

[0041]

As the glass substrate, a glass containing no alkali or alkali at a low concentration or a quartz glass such as Corning 7059, Corning 1737, NH technoglass NA 45, NH technoglass NA 35 or Japan electric glass OA2 may be used. When a quartz glass is used, there is a problem in its cost. However, since, in the present invention, an area used in one liquid crystal display device is extremely small, a cost per unit is sufficiently

low.

[0042]

A silicon oxide film 153 having a thickness of 200 nm is deposited on the silicon film 151. Since the silicon oxide film is used as a base film, it is necessary to pay sufficient attention to its formation. By a known method, crystalline island silicon regions (silicon islands) 154 and 155 are formed. A thickness of the silicon films influence characteristics of a necessary semiconductor circuit. In general, it is preferable to be a thin film. In the embodiment, the thickness is 40 to 60 nm.

[0043]

To obtain crystalline silicon, a method for irradiating an intense light such as a laser into amorphous silicon (a laser annealing method) or a method for making solid phase growth by thermal annealing (a solid phase growth method) is used. In using the solid phase growth method, as disclosed in Japanese Patent Application Laid-Open No. 6-244104, when a catalytic element such as nickel is added to silicon, a crystallization temperature can be reduced and an annealing time can be shortened. Also, as disclosed in Japanese Patent Application Laid-Open No. 6-318701, silicon crystallized by the solid phase growth method may be annealed by laser. A method to be used may be determined in accordance with characteristics of a necessary semiconductor integrated circuit, a heat-resistance temperature of a substrate and the like.

[0044]

By plasma CVD or thermal CVD, a gate insulating film 156 made of a silicon oxide having a thickness of 120 nm is deposited, and then gate electrode-wirings 157 and 158 using crystalline silicon having a thickness of 500 nm are formed. The gate wirings may be a metal such as aluminum, tungsten or titanium, or silicide thereof. When metal gate electrode is formed, as disclosed in Japanese Patent Application Laid-

Open No. 5-267667 or 6-338612, an upper or a side surface of the gate electrode may be coated with an anodic oxide. A material constructing the gate electrode may be determined in accordance with characteristics of a necessary semiconductor circuit, a heat-resistance temperature of a substrate and the like. (Fig. 7(A))

[0045]

Thereafter, in a self-alignment, an N-type and a P-type impurities are introduced into the silicon islands by ion doping or the like, to form N-type region 159 and P-type region 160. An interlayer insulator 161 (a silicon oxide film having a thickness of 500 nm) is deposited by a known method, and then contact holes are formed therein, to form aluminum alloy wirings 162 to 164. (Fig. 7(B))

[0046]

A polyimide film 170 is formed on the aluminum alloy wirings as a passivation film by adding varnish and then curing it. In the embodiment, Photoneath UR-3800 of Toray Industries Inc. is used. Addition is performed by a spinner. An addition condition may be determined in accordance with a desired film thickness. The polyimide film having a thickness of about 4 $\mu$ m is formed at 2000 rpm for 25 seconds. The thickness of the polyimide film is set in accordance with a diameter of spacers. After drying, exposure and development are performed. By selecting a desired condition, a desired tapered pattern can be obtained. Then, the film is cured by processing at 300 °C in an atmosphere containing nitrogen. (Fig. 7(C)) Subsequently, a transfer substrate 172 is adhered to the semiconductor integrated circuit by a resin 171. It is desired that the transfer substrate has a strength and a flat surface to hold the integrated circuit impermanently. Thus, glass, plastic or the like can be used. Since the transfer substrate is peeled later, it is preferable that the resin 71 is a material being easy to remove. Also, a material such as an adhesive which is easy to peel off, may be used. (Fig. 8(A))

[0047]

The processed substrate is left in air flow of a mixture gas of fluorine trichloride ( $\text{ClF}_3$ ) and nitrogen. A flow rate of fluorine trichloride and nitrogen is 500 sccm. A reaction process is 1 to 10 Torr. A temperature is a room temperature. It has been known that fluorine halide such as fluorine trichloride has a characteristic for selectively etching silicon. Silicon oxide is not almost etched. Thus, the peeling layer is etched in accordance with an elapse, however, the base layer 153 is not almost etched. Therefore, a TFT element is not damaged. When further elapsing a time, the base layer is etched completely, thereby to peel the peripheral driver circuit completely. (Fig. 8(B))

Then, the peeled peripheral driver circuit is adhered to the substrate 175 of the liquid crystal display device by a resin 176, thereby the transfer substrate 172 is removed. (Fig. 8(C)) In this way, a transfer of the peripheral driver circuit to the substrate of the display device. As a substrate of the liquid crystal display device, polyether sulfate (PES) having a thickness of 0.3 mm was used.

[0048]

Then, an indium tin oxide (ITO) film 180 having a thickness of 100 nm is formed by sputtering. The ITO film is a transparent conductive oxide and patterned to complete electrical connection between the electrical wirings and the peripheral driver circuit. (Fig. 8(D))

As a result, the formation of the semiconductor integrated circuit on one substrate of the liquid crystal display device is completed.

[0049]

Next, a producing process for a passive matrix type liquid crystal display device is explained below.

The first and second substrates produced by the above processes are sufficiently

washed to remove various chemicals such as an etching solution, a resist solution and a peeling solution which are used for surface-processing.

An alignment film is adhered to an electrode region which is made of ITO and constructs pixels. An alignment material is obtained by dissolving, in a solvent such as butyl cellosolve or N-methyl pyrrolidone, a polyimide having about 10 weight % of the solvent.

Then, alignment films adhered to the first and second substrates are heated and cured (baked).

Thereafter, a rubbing treatment is performed so that a surface of a glass substrate to which the alignment film is adhered is rubbed in a desired direction by using a buff cloth (a fiber such as rayon and nylon) having of a wool length of 2 to 3 mm at a surface and thus fine grooves are formed.

[0050]

Spherical spacers of a polymer system, a glass system, a silica system or the like are scattered (dispersed) on one of the first and second substrates.

A spacer scattering method includes a wet method for scattering, on a substrate, spacers into which a solvent such as pure water or alcohol is mixed and a dry method for scattering, on a substrate, spacers without using a solvent. In the embodiment, the dry method was used.

[0051]

Thereafter, a resin used as a seal material provided in an outer side of a substrate is applied.

The seal material to be used is obtained by dissolving an epoxy resin and a phenol curing agent in a solvent of ethyl cellosolve. An acrylate system resin may be used. Also, a thermal-curable type or a ultraviolet-curable type may be used.

By a screen printing method, a seal material is applied and formed on the first substrate or the second substrate.

[0052]

After forming the seal material, two glass substrates are adhered to one another.

As a method for adhering and curing, a heating curing method for curing a seal material for about 3 hours by high temperature press at about 160 °C is used.

A liquid crystal material is injected from a liquid crystal inlet of the passive matrix type display device produced by adhering the first and second substrates, and then the liquid crystal inlet is sealed by using an epoxy system resin.

Thus, the passive matrix type liquid crystal display device is completed.

[0053]

#### [EFFECT OF THE INVENTION]

According to the present invention, in a liquid crystal display device that a peripheral driver circuit is provided in a liquid crystal region wherein contamination resistance and humidity resistance of the peripheral driver circuit are improved and an external appearance is simple, breaking of the peripheral driver circuit due to a stress pressure to a substrate can be prevented and a substrate interval can be maintained constant. In particular, in a liquid crystal display device in which a plastic substrate modifiable by an external stress is used, breaking of the peripheral circuit can be prevented. Thus, reliability and durability of the liquid crystal display device can be improved further.

#### [BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 shows an example of a liquid crystal display device according to the present invention;

Fig. 2 shows a schematic diagram of a producing method of a display device of

the present invention;

Fig. 3 show an example of a conventional liquid crystal display device;

Fig. 4 is a cross section view in a line A-A' of Fig. 1;

Fig. 5 shows a producing process of a stick substrate used in the present invention;

Fig. 6 shows a process for adhering a peripheral driver circuit formed on a stick substrate to another substrate of a display device;

Fig. 7 shows an example of a producing process of a display device according to the present invention;

Fig. 8 shows an example of a producing process of a display device according to the present invention.

#### [EXPLANATION OF MARKS]

101 . . . first substrate, 102 . . . second substrate, 103 . . . peripheral driver circuit on the first substrate, 104 . . . peripheral driver circuit on the second substrate, 105 . . . display pixel electrode, 106 . . . liquid crystal, 107 . . . seal material,

109 . . . outer connection terminal, 110 and 111 . . . protective film on a peripheral driver circuit, 21 . . . substrate which constitutes a peripheral driver circuit, 22 . . . semiconductor integrated circuit, 23 and 24 . . . stick substrate,

25 and 27 . . . substrate of liquid crystal display device, 26 and 28 . . . surface on which a wiring pattern is formed, 29 and 30 . . . driver circuit transferred on a substrate of a liquid crystal display device, 26 . . . reverse surface of a surface on which a wiring pattern is formed, 301 . . . first substrate, 302 . . . second substrate(counter substrate), 303 and 304 . . . peripheral driver circuit,

305 . . . active matrix circuit, 306 . . . liquid crystal material, 307 . . . seal material, 309 . . . outer connection terminal, 401 . . . spacer, 402 . . . external stress to substrate, 31 . . .

substrate which constitutes stick crystal, 32 . . . peeling layer,  
33 . . . base film, 34 and 35 . . . silicon island, 36 . . . gate insulating film,  
37 and 38 . . . gate electrode, 39 . . . N-type region, 40 . . . P-type region,  
41 . . . interlayer insulator, 42 to 44 . . . aluminum alloy wiring,  
46 . . . passivation film, 47 . . . conductive oxide film, 48 . . . bump,  
49 . . . substrate of a liquid crystal display device, 50 . . . electrode of a liquid crystal  
display device, 51 . . . adhesive, 52 . . . opening, 53 . . . bottom surface of base film, 150  
. . . substrate for producing a semiconductor integrated circuit,  
151 . . . peeling layer, 153 . . . base film, 154 and 155 . . . silicon island,  
156 . . . interlayer insulating film, 157 and 158 . . . gate electrode,  
159 . . . N-type region, 160 . . . P-type region, 161 . . . gate insulating film,  
162 to 164 . . . aluminum alloy electrode, 170 . . . passivation film,  
171 . . . adhesive, 172 . . . transfer substrate, 175 . . . substrate of liquid crystal display  
device, 176 . . . resin, and 180 . . . wiring electrode

## [NAME OF DOCUMENT] ABSTRACT

### [SUMMARY]

### [PURPOSE]

The reliability of a passive matrix type and an active matrix type liquid crystal display device on which a pixel region and a peripheral driver circuit region are integrated is improved.

### [CONSTITUTION]

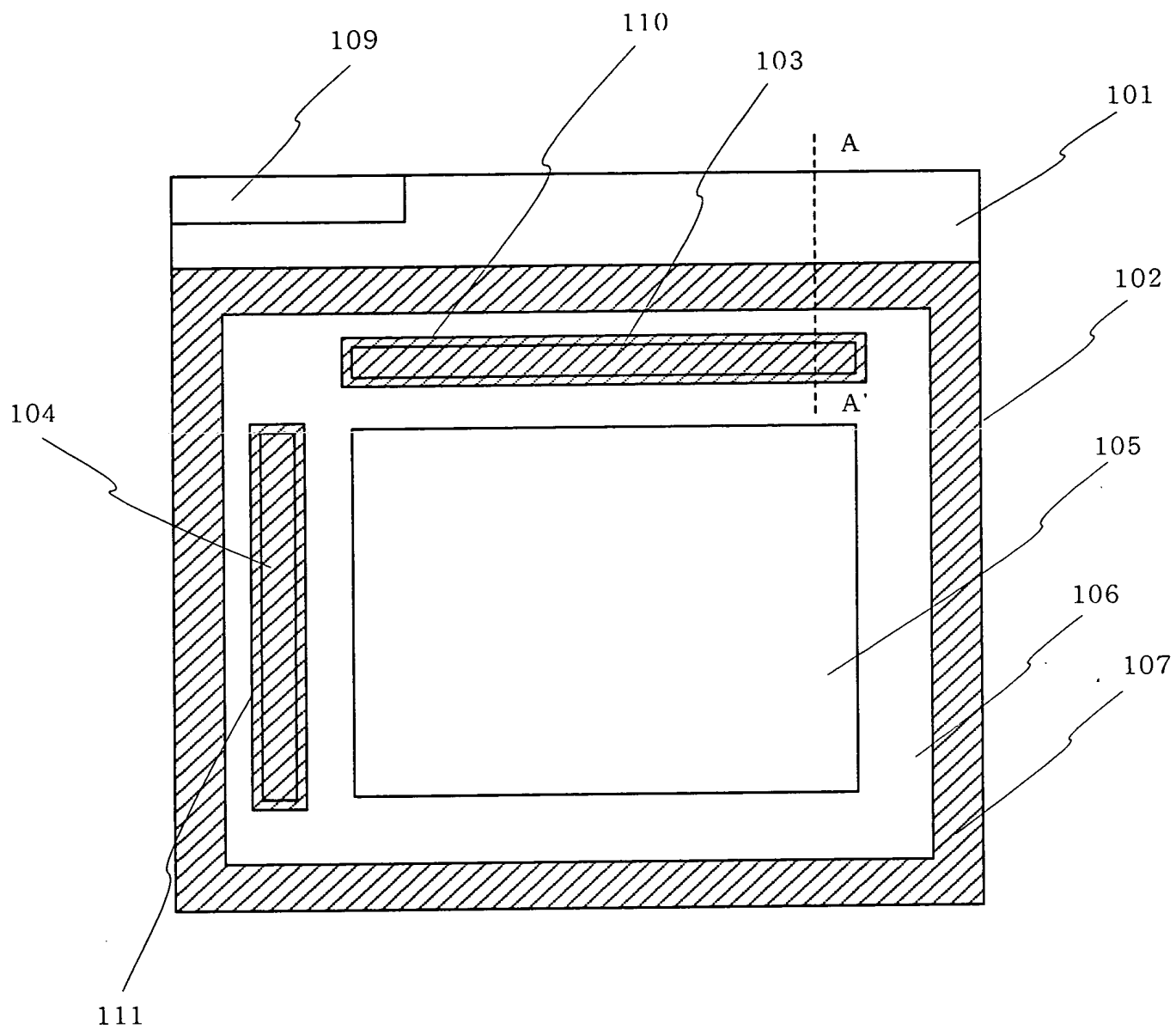
In a method of forming a peripheral driver circuit by transferring on a substrate which constitutes a liquid crystal display device after forming said peripheral driver circuit on another supporting substrate, the peripheral driver circuit is disposed inside a seal material of a liquid crystal. At the time, the thickness of a protective film is the same with the thickness of a seal material or a spacer, thereby a long-term reliability of the peripheral driver circuit is improved. This structure has an effect of improve the reliability in the liquid crystal display device using a plastic substrate which is modifiable by external stress.

[SELECTED FIGURE] Fig. 1

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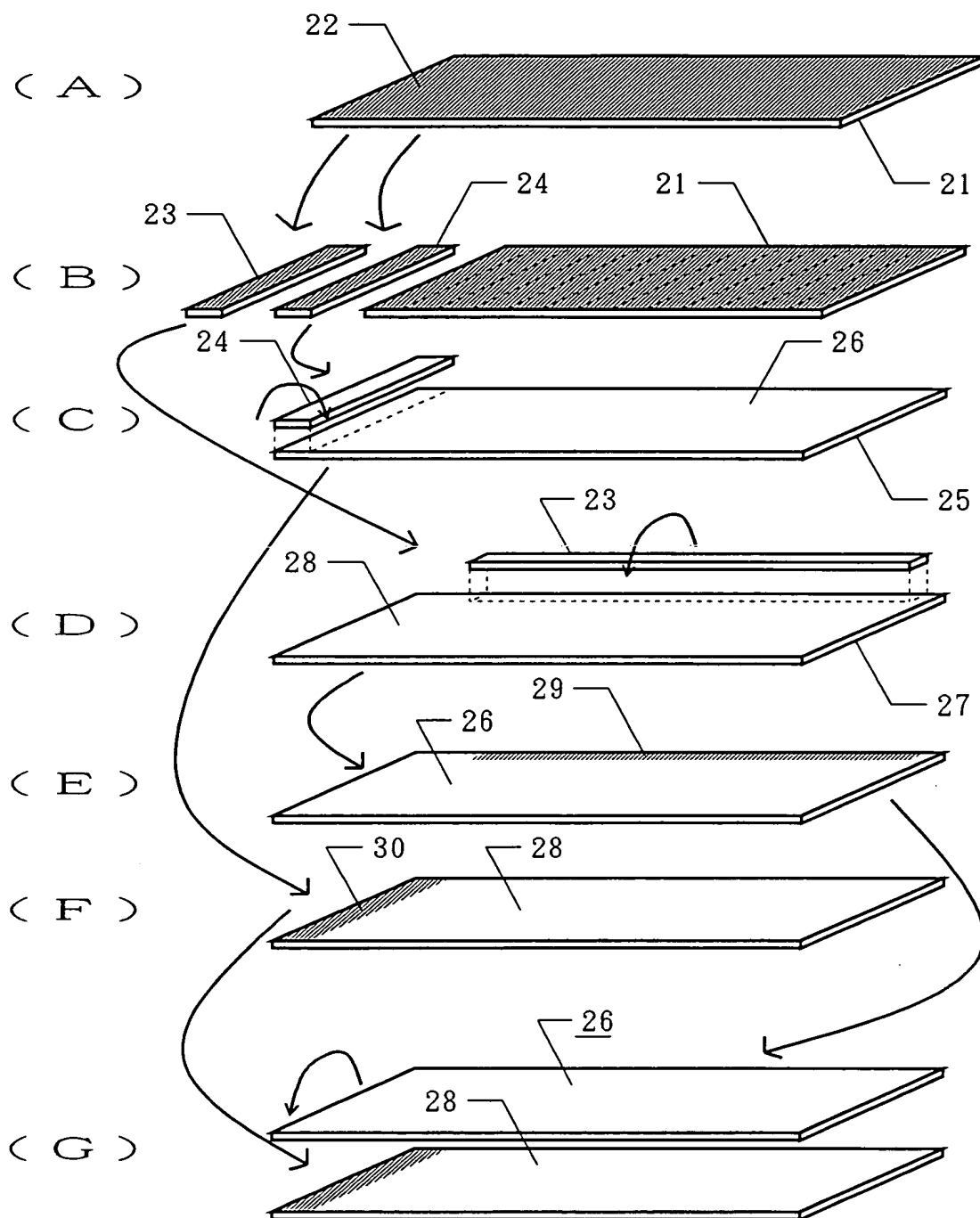
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【図1】



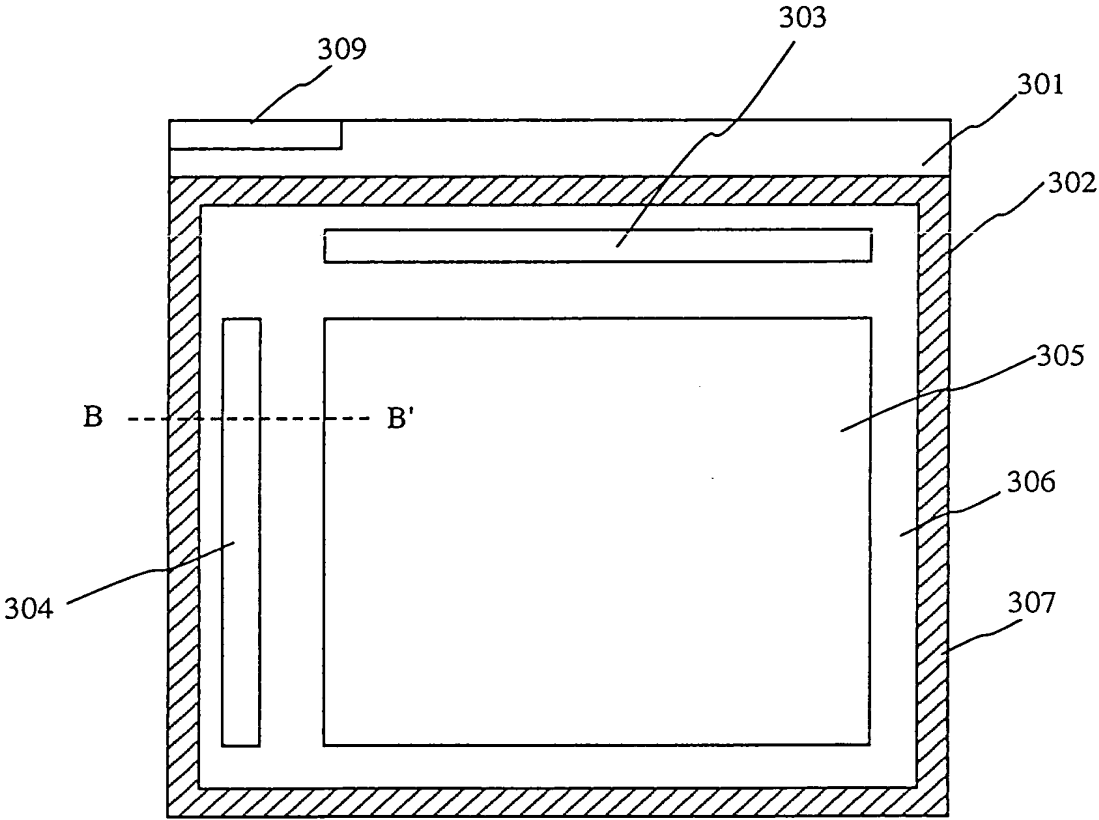
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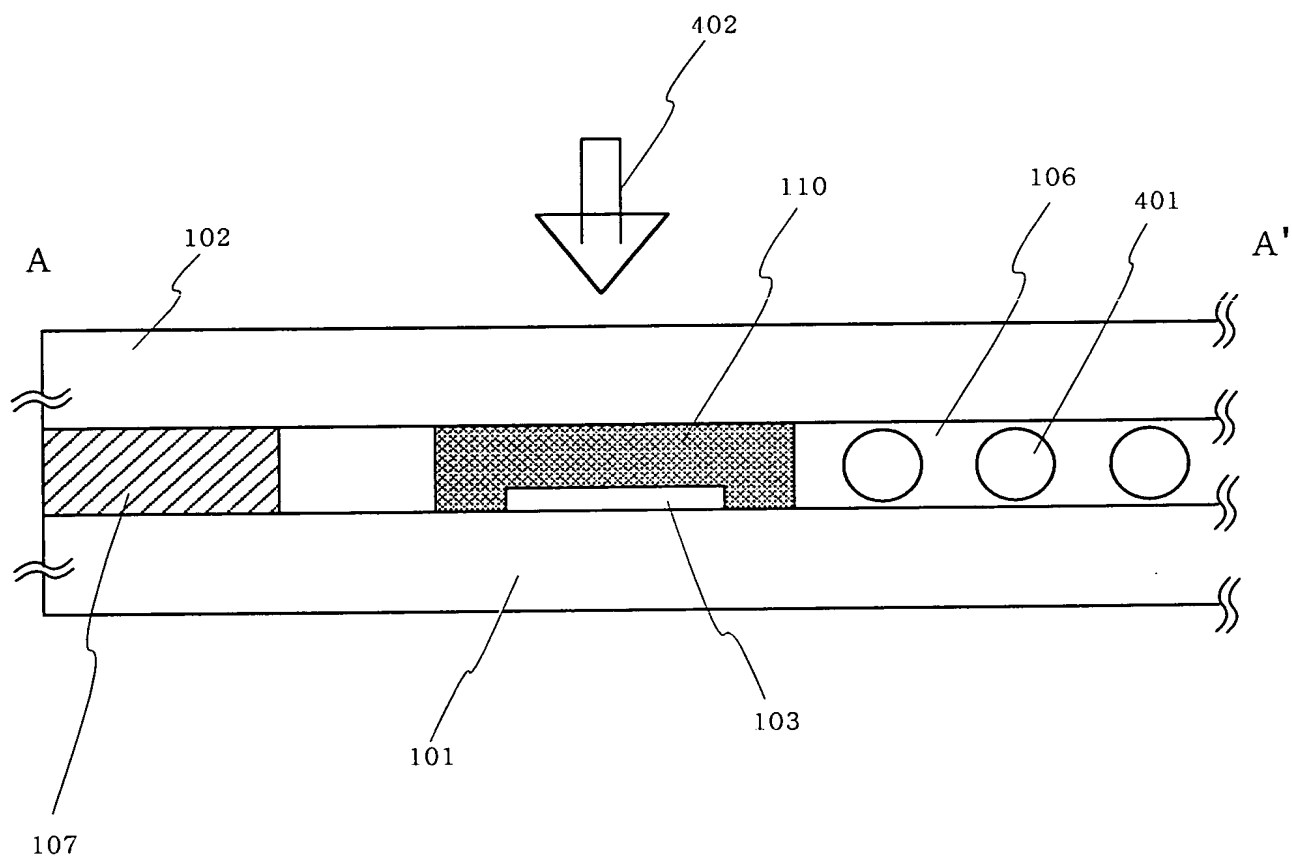


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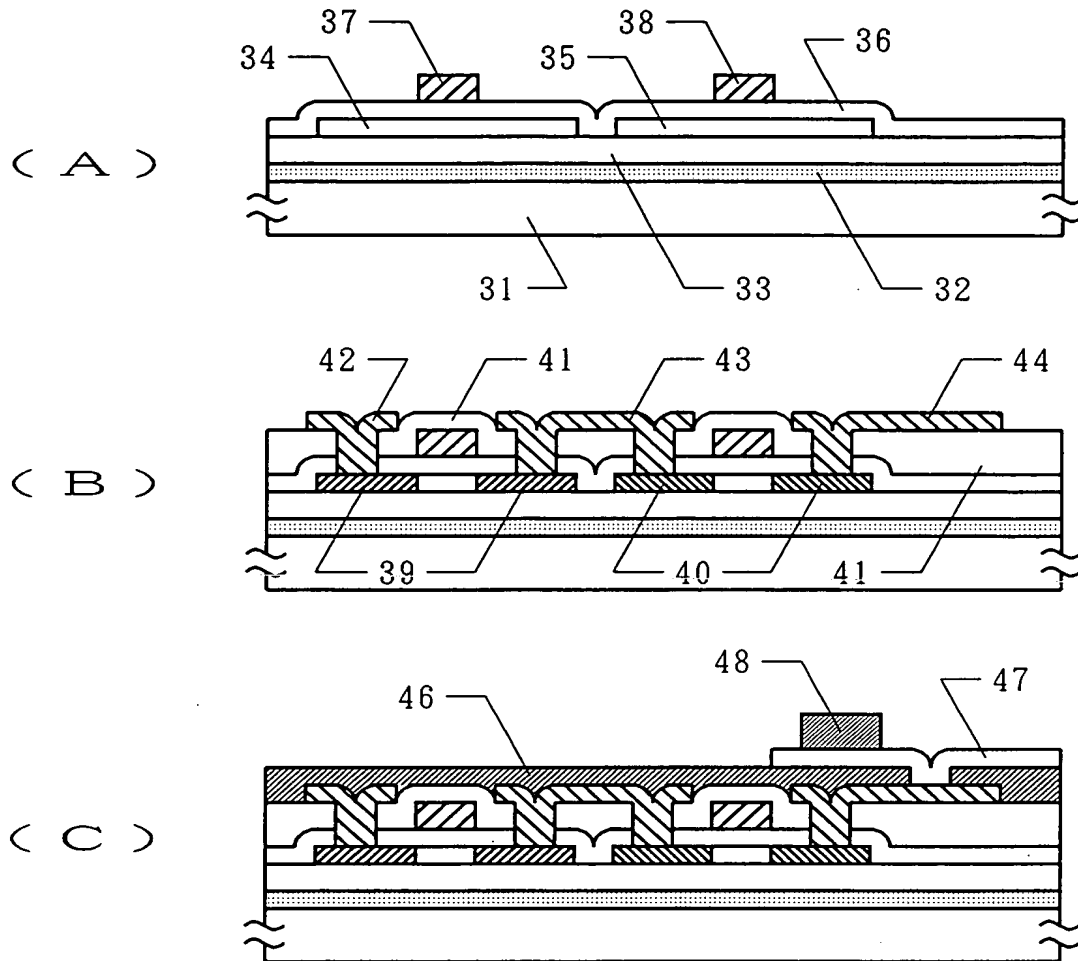
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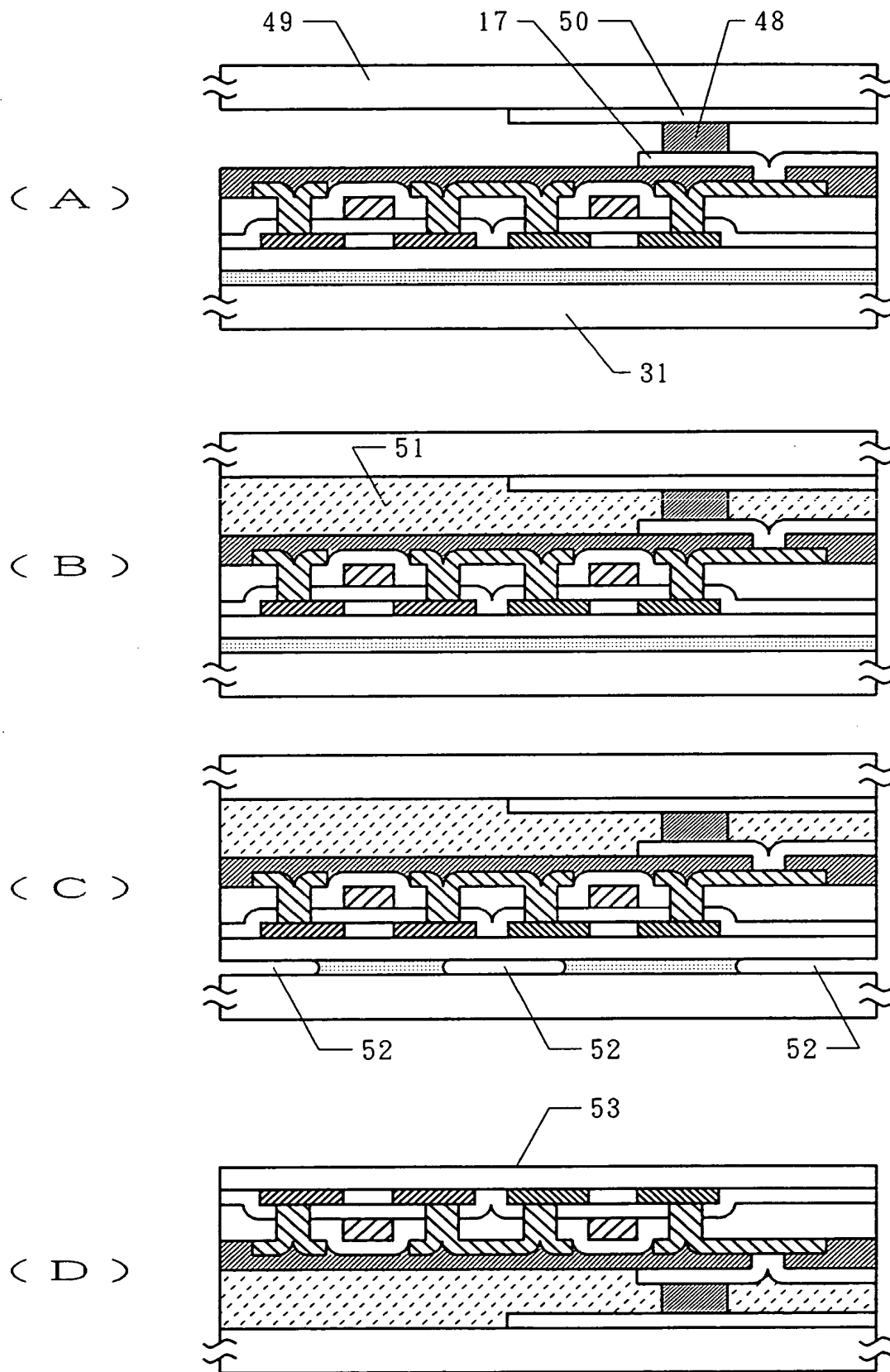
【図 4】



【図 5】

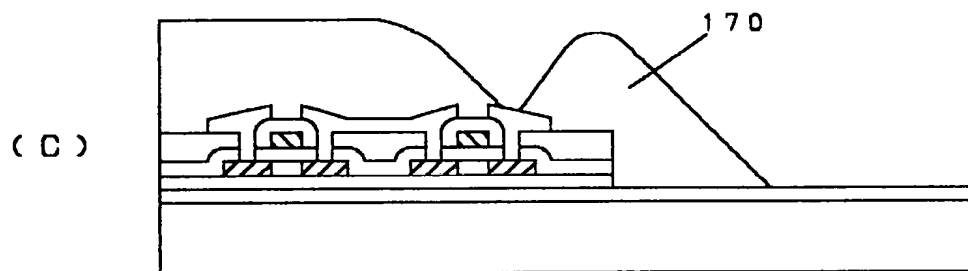
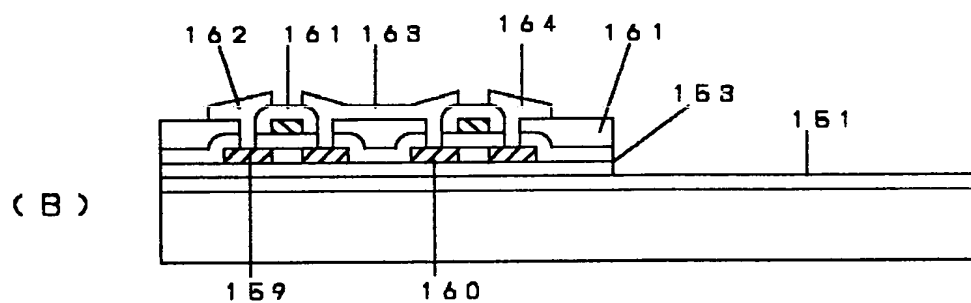
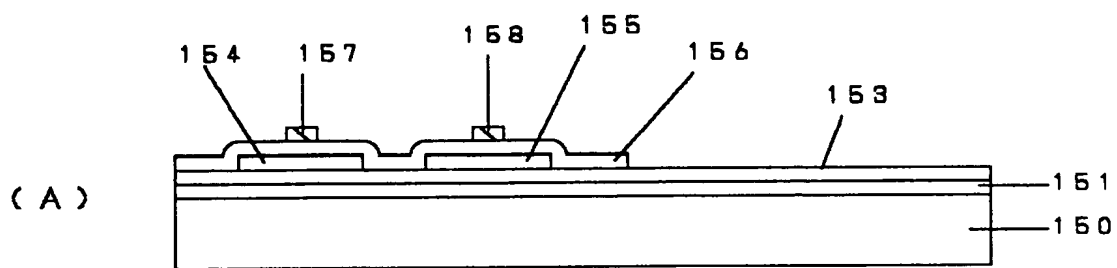


【図 6】



【整理番号】

【図7】



【整理番号】

【図8】

